CLAIM AMENDMENTS

Please cancel claim 94, add claims 156-157, amend the remaining claims as follows:

Claims 1-19. (Canceled)

20. (Currently amended) An optical identification element having a chemical attached thereto, comprising:

a substrate;

at least a portion of said substrate being made of a substantially single material and having at least one diffraction grating embedded ~~disposed~~ therein, said grating having a resultant refractive index variation within the substantially single material at a grating location~~, said grating being embedded within a substantially single material of said substrate~~; and

said grating providing an output optical signal indicative of a code when illuminated by an incident light signal propagating from outside the substrate ~~in free space, said code identifying at least one of the element and said chemical~~, said output optical signal ~~not~~ being a result of passive, non-resonant scattering from ~~laser action with~~ said grating when illuminated by said incident light signal; and

the chemical being attached to at least a portion of said substrate.

21. (Previously presented) The apparatus of claim 20 wherein said refractive index variation comprises at least one refractive index pitch superimposed at said grating location.

22. (Previously presented) The apparatus of claim 20 wherein said refractive index variation comprises a plurality of refractive index pitches superimposed at said grating location.

23. (Previously presented) The apparatus of claim 20 wherein said substrate is made of a material selected from the group: glass, silica, plastic, rubber, and polymer.

24. (Previously presented) The apparatus of claim 20 wherein said code comprises a plurality of digital bits.

25. (Previously presented) The apparatus of claim 20 wherein said code comprises at least a predetermined number of bits, said number being: 3, 5, 7, 9, 10, 12, 14, 16, 18, 20, 24, 28, 30, 40, 50, or 100.

26. (Previously presented) The apparatus of claim 20 wherein said code comprises a plurality of bits, each bit having a plurality of states.

27. (Currently amended) The apparatus of claim 20 wherein said code comprises a plurality of bits, each bit having a corresponding spatial location and each bit in said code having a value related to the intensity of said output optical signal at the spatial location of each bit.

28. (Previously presented) The apparatus of claim 27 wherein the value of each bit corresponds to the magnitude of refractive index variation of a corresponding refractive index pitch in said grating.

29. (Currently amended) The apparatus of claim 20 wherein said code comprises a plurality of digital bits, each bit having a corresponding spatial location and each bit in said code having a binary value related to the intensity of said output optical signal at the spatial location of each bit.

30. (Previously presented) The apparatus of claim 29 wherein the value of each bit corresponds to the presence or absence of a corresponding refractive index pitch in said grating.

31. (Currently amended) The apparatus of claim ~~1~~ 20 wherein said incident beam ~~light~~ comprises a single wavelength.

32. (Previously presented) The apparatus of claim 20 wherein said incident light comprises a plurality of wavelengths or a single wavelength scanned over a predetermined wavelength range.

33. (Previously presented) The apparatus of claim 32 wherein said code comprises a plurality of bits, and each bit in said code having a value related to the intensity of said output optical signal at a wavelength corresponding to each bit.

34. (Previously presented) The apparatus of claim 33 wherein the value of each bit corresponds to the magnitude of refractive index variation of a corresponding refractive index pitch in said grating.

35. (Previously presented) The apparatus of claim 32 wherein said code comprises a plurality of digital bits, and each bit in said code having a binary value related to the intensity of said output optical signal at the wavelength corresponding to each bit.

36. (Previously presented) The apparatus of claim 35 wherein the value of each bit corresponds to the presence or absence of a corresponding refractive index pitch in said grating.

37. (Previously presented) The apparatus of claim 20 wherein said substrate has a length that is less than about 500 microns.

38. (Previously presented) The apparatus of claim 20 wherein said substrate has a diameter that is less than about 125 microns.

39. (Previously presented) The apparatus of claim 20 wherein said substrate has a reflective coating disposed thereon.

40. (Previously presented) The apparatus of claim 20 wherein said substrate has a coating disposed on at least a portion of said substrate, at least a portion of said coating being made of a material that allows sufficient amount of said incident light signal to pass through said material to allow detection of said code.

41. (Previously presented) The apparatus of claim 20 wherein said substrate has a coating material disposed on at least a portion of said substrate, said coating comprising a polymer.

42. (Previously presented) The apparatus of claim 20 wherein said substrate has a magnetic or electric charge polarization.

43. (Previously presented) The apparatus of claim 20 wherein said substrate has geometry having holes therein or protruding sections therein.

44. (Previously presented) The apparatus of claim 20 wherein at least a portion of said substrate has an end cross sectional geometry selected from the group: circular, square, rectangular, elliptical, clam-shell, D-shaped, and polygon.

45. (Previously presented) The apparatus of claim 20 wherein at least a portion of said substrate has a side view geometry selected from the group: circular, square, rectangular, elliptical, clam-shell, D-shaped, and polygon.

46. (Previously presented) The apparatus of claim 20 wherein at least a portion of said substrate has a 3-D shape selected from the group: a cylinder, a sphere, a cube, and a pyramid.

47. (Previously presented) The apparatus of claim 20 wherein said substrate has a grating region where said grating is located and a non-grating region where said grating is not located; and wherein said substrate has a plurality of grating regions.

48. (Previously presented) The apparatus of claim 20 wherein said substrate has a grating region where said grating is located and a non-grating region where said grating is not located; and wherein said grating region has a refractive index that is greater than that of said non-grating region.

49. (Previously presented) The apparatus of claim 20 wherein said substrate has a grating region where said grating is located and a non-grating region where said grating is not located; and wherein said grating region has a refractive index that is not greater than that of said non-grating region.

50. (Previously presented) The apparatus of claim 20 wherein said incident light is incident on said substrate along a longitudinal grating axis of said grating.

51. (Previously presented) The apparatus of claim 20 wherein said incident light is incident on said substrate at an angle to a longitudinal grating axis of said grating.

52. (Previously presented) The apparatus of claim 20 wherein said incident light comprises laser light.

53. (Previously presented) The apparatus of claim 20 wherein said grating is a thin grating or a blazed grating.

54. (Previously presented) The apparatus of claim 20 wherein said substrate comprises a plurality of said gratings.

55. (Previously presented) The apparatus of claim 20 wherein said substrate comprises a plurality of said gratings each at different locations within said substrate.

56. (Previously presented) The apparatus of claim 20 wherein said substrate comprises a particle or bead.

57. (Currently amended) The apparatus of claim 20 wherein said chemical comprises at least one gene, oligonucleotide, protein, antibody, peptide, amino acid,

DNA ~~NDA,~~ cDNA, RNA, nucleic acid oligomer, polymer, or biological cell, or portion thereof.

58. (Currently amended) An encoded particle having a chemical attached thereto, comprising:

a particle;

at least a portion of said particle being made of a substantially single material and having at least one diffraction grating embedded ~~disposed~~ therein, said grating having a resultant refractive index variation within the substantially single material at a grating location~~, said grating being embedded within a substantially single material of said particle~~; and

said grating providing an output optical signal indicative of a code when illuminated by an incident light signal propagating from outside the substrate~~in free space, said code identifying at least one of the particle and said chemical~~, said output optical signal ~~not~~ being a result of passive, non-resonant scattering from ~~laser action with~~ said grating when illuminated by said incident light signal; and

the chemical being attached to at least a portion of said particle.

59. (Previously presented) The apparatus of claim 58 wherein said refractive index variation comprises at least one refractive index pitch superimposed at said grating location.

60. (Previously presented) The apparatus of claim 58 wherein said refractive index variation comprises a plurality of refractive index pitches superimposed at said grating location.

61. (Previously presented) The apparatus of claim 58 wherein said particle is made of a material selected from the group: glass, silica, plastic, rubber, and polymer.

62. (Previously presented) The apparatus of claim 58 wherein said code comprises a plurality of digital bits.

63. (Previously presented) The apparatus of claim 58 wherein said code comprises at least a predetermined number of bits, said number being: 3, 5, 7, 9, 10, 12, 14, 16, 18, 20, 24, 28, 30, 40, 50, or 100.

64. (Previously presented) The apparatus of claim 58 wherein said code comprises a plurality of bits, each bit having a plurality of states.

65. (Currently amended) The apparatus of claim 58 wherein said code comprises a plurality of bits, each bit having a corresponding spatial location in said output optical signal and each bit in said code having a value related to the intensity of said output optical signal at the spatial location of each bit.

66. (Previously presented) The apparatus of claim 65 wherein the value of each bit corresponds to the magnitude of refractive index variation of a corresponding refractive index pitch in said grating.

67. (Currently amended) The apparatus of claim 58 wherein said code comprises a plurality of digital bits, each bit having a corresponding spatial location in said output optical signal and each bit in said code having a binary value related to the intensity of said output optical signal at the spatial location of each bit.

68. (Previously presented) The apparatus of claim 67 wherein the value of each bit corresponds to the presence or absence of a corresponding refractive index pitch in said grating.

69. (Previously presented) The apparatus of claim 58 wherein said incident light comprises a single wavelength.

70. (Previously presented) The apparatus of claim 58 wherein said incident light comprises a plurality of wavelengths or a single wavelength scanned over a predetermined wavelength range.

71. (Previously presented) The apparatus of claim 70 wherein said code comprises a plurality of bits, and each bit in said code having a value related to the intensity of said output optical signal at a wavelength corresponding to each bit.

72. (Previously presented) The apparatus of claim 71 wherein the value of each bit corresponds to the magnitude of refractive index variation of a corresponding refractive index pitch in said grating.

73. (Previously presented) The apparatus of claim 70 wherein said code comprises a plurality of digital bits, and each bit in said code having a binary value related to the intensity of said output optical signal at the wavelength corresponding to each bit.

74. (Previously presented) The apparatus of claim 73 wherein the value of each bit corresponds to the presence or absence of a corresponding refractive index pitch in said grating.

75. (Currently amended) The apparatus of claim 58 wherein said particle has a length that is less than about <u>1000</u> ~~500~~ microns.

76. (Currently amended) The apparatus of claim 58 wherein said particle has a diameter that is less than about <u>1000</u> ~~125~~ microns.

77. (Previously presented) The apparatus of claim 58 wherein said particle has a reflective coating disposed thereon.

78. (Previously presented) The apparatus of claim 58 wherein said particle has a coating disposed on at least a portion of said particle, at least a portion of said coating being made of a material that allows sufficient amount of said incident light signal to pass through said material to allow detection of said code.

79. (Previously presented) The apparatus of claim 58 wherein said particle has a coating material disposed on at least a portion of said particle, said coating comprising a polymer.

80. (Previously presented) The apparatus of claim 58 wherein said particle has a magnetic or electric charge polarization.

81. (Previously presented) The apparatus of claim 58 wherein said particle has geometry having holes therein or protruding sections therein.

82. (Previously presented) The apparatus of claim 58 wherein at least a portion of said particle has an end cross sectional geometry selected from the group: circular, square, rectangular, elliptical, clam-shell, D-shaped, and polygon.

83. (Previously presented) The apparatus of claim 58 wherein at least a portion of said particle has a side view geometry selected from the group: circular, square, rectangular, elliptical, clam-shell, D-shaped, and polygon.

84. (Previously presented) The apparatus of claim 58 wherein at least a portion of said particle has a 3-D shape selected from the group: a cylinder, a sphere, a cube, and a pyramid.

85. (Previously presented) The apparatus of claim 58 wherein said particle has a grating region where said grating is located and a non-grating region where said grating is not located; and wherein said particle has a plurality of grating regions.

86. (Previously presented) The apparatus of claim 58 wherein said particle has a grating region where said grating is located and a non-grating region where said grating is not located; and wherein said grating region has a refractive index that is greater than that of said non-grating region.

87. (Previously presented) The apparatus of claim 58 wherein said particle has a grating region where said grating is located and a non-grating region where said grating is not located; and wherein said grating region has a refractive index that is not greater than that of said non-grating region.

88. (Previously presented) The apparatus of claim 58 wherein said incident light is incident on said particle along a longitudinal grating axis of said grating.

89. (Previously presented) The apparatus of claim 58 wherein said incident light is incident on said particle at an angle to a longitudinal grating axis of said grating.

90. (Previously presented) The apparatus of claim 58 wherein said incident light comprises laser light.

91. (Previously presented) The apparatus of claim 58 wherein said grating is a thin grating or a blazed grating.

92. (Previously presented) The apparatus of claim 58 wherein said particle comprises a plurality of said gratings.

93. (Previously presented) The apparatus of claim 58 wherein said particle comprises a plurality of said gratings each at different locations within said particle.

94. (Cancelled) ~~The apparatus of claim 58 wherein said particle comprises a particle or bead.~~

95. (Currently amended) The apparatus of claim 58 wherein said chemical comprises at least one gene, oligonucleotide, protein, antibody, peptide, amino acid, DNA, ~~NDA,~~ cDNA, RNA, nucleic acid oligomer, polymer, or biological cell, or portion thereof.

96. (Currently amended) A method of reading an encoded optical identification element having a chemical attached thereto, comprising:

obtaining a substrate, at least a portion of which being made of a substantially single material and having at least one diffraction grating embedded ~~disposed~~ therein, said grating having a resultant refractive index variation within the substantially single material at a grating location~~, said grating being embedded within a substantially single material of said substrate~~;

attaching the chemical to at least a portion of said substrate;

illuminating said substrate with incident light ~~propagating in free space~~, said substrate providing an output optical ~~light~~ signal indicative of a code, ~~said code identifying at least one of the element and said chemical,~~ said output optical signal ~~not~~ being a result of passive, non-resonant scattering from ~~laser action with~~ said grating when illuminated by said incident light; and

reading said output light signal and detecting said code therefrom.

97. (Previously presented) The method of claim 96 wherein said refractive index variation comprises at least one refractive index pitch superimposed at said grating location.

98. (Previously presented) The method of claim 96 wherein said refractive index variation comprises a plurality of refractive index pitches superimposed at said grating location.

99. (Previously presented) The method of claim 96 wherein said substrate is made of a material selected from the group: glass, silica, plastic, rubber, and polymer.

100. (Previously presented) The method of claim 96 wherein said code comprises a plurality of digital bits.

101. (Previously presented) The method of claim 96 wherein said code comprises at least a predetermined number of bits, said number being: 3, 5, 7, 9, 10, 12, 14, 16, 18, 20, 24, 28, 30, 40, 50, or 100.

102. (Currently amended) The method of claim 96 wherein said code comprises a plurality of digital bits, each bit having a corresponding spatial location in said output optical signal and each bit in said code having a binary value related to the intensity of said output optical signal at the spatial location of each bit.

103. (Previously presented) The method of claim 102 wherein the value of each bit corresponds to the presence or absence of a corresponding refractive index pitch in said grating.

104. (Previously presented) The method of claim 96 wherein said incident light comprises a single wavelength.

105. (Previously presented) The method of claim 96 wherein said substrate has a coating disposed on at least a portion of said substrate, at least a portion of said coating being made of a material that allows sufficient amount of said incident light signal to pass through said material to allow detection of said code.

106. (Previously presented) The method of claim 96 wherein at least a portion of said substrate has a 3-D shape selected from the group: a cylinder, a sphere, a cube, and a pyramid.

107. (Previously presented) The method of claim 96 wherein said substrate has a grating region where said grating is located and a non-grating region where said grating is not located; and wherein said substrate has a plurality of grating regions.

108. (Previously presented) The method of claim 96 wherein said substrate has a grating region where said grating is located and a non-grating region where said grating is not located; and wherein said grating region has a refractive index that is greater than that of said non-grating region.

109. (Previously presented) The method of claim 96 wherein said substrate has a grating region where said grating is located and a non-grating region where said grating is not located; and wherein said grating region has a refractive index that is not greater than that of said non-grating region.

110. (Previously presented) The method of claim 96 wherein said incident light is incident on said substrate along a longitudinal grating axis of said grating.

111. (Previously presented) The method of claim 96 wherein said incident light is incident on said substrate at an angle to a longitudinal grating axis of said grating.

112. (Previously presented) The method of claim 96 wherein said grating comprises a thin grating.

113. (Previously presented) The method of claim 96 wherein said substrate comprises a plurality of said gratings.

114. (Previously presented) The method of claim 96 wherein said substrate comprises a particle or bead.

115. (Currently amended) The method of claim 96 wherein said chemical comprises at least one gene, oligonucleotide, protein, antibody, peptide, amino acid, NDA, cDNA, RNA, nucleic acid oligomer, polymer, or biological cell, or portion thereof.

116. (Currently amended) A method of reading an encoded particle having a chemical attached thereto, comprising:

obtaining a particle, at least a portion of which being made of a substantially single material and having at least one diffraction grating embedded ~~disposed~~ therein, said grating having a resultant refractive index variation within the substantially single material at a grating location~~, said grating being embedded within a substantially single material of said particle~~;

attaching the chemical to at least a portion of said particle;

illuminating said particle with incident light, said particle providing an output optical ~~light~~ signal indicative of a code, ~~said code identifying at least one of the particle and said chemical,~~ said output signal ~~not~~ being a result of passive, non-resonant scattering from ~~laser action with~~ said grating when illuminated by said incident light; and

reading said output light signal and detecting said code therefrom.

117. (Previously presented) The method of claim 116 wherein said refractive index variation comprises at least one refractive index pitch superimposed at said grating location.

118. (Previously presented) The method of claim 116 wherein said refractive index variation comprises a plurality of refractive index pitches superimposed at said grating location.

119. (Previously presented) The method of claim 116 wherein said particle is made of a material selected from the group: glass, silica plastic, rubber, and polymer.

120. (Previously presented) The method of claim 116 wherein said code comprises a plurality of digital bits.

121. (Previously presented) The method of claim 116 wherein said code comprises at least a predetermined number of bits, said number being: 3, 5, 7, 9, 10, 12, 14, 16, 18, 20, 24, 28, 30, 40, 50, or 100.

122. (Currently amended) The method of claim 116 wherein said code comprises a plurality of digital bits, each bit having a corresponding spatial location in said optical output signal and each bit in said code having a binary value related to the intensity of said output optical signal at the spatial location of each bit.

123. (Previously presented) The method of claim 122 wherein the value of each bit corresponds to the presence or absence of a corresponding refractive index pitch in said grating.

124. (Previously presented) The method of claim 116 wherein said incident light comprises a single wavelength.

125. (Previously presented) The method of claim 116 wherein said substrate has a coating disposed on at least a portion of said substrate, at least a portion of said coating being made of a material that allows sufficient amount of said incident light signal to pass through said material to allow detection of said code.

126. (Previously presented) The method of claim 116 wherein at least a portion of said substrate has a 3-D shape selected from the group: a cylinder, a sphere, a cube, and a pyramid.

127. (Previously presented) The method of claim 116 wherein said substrate has a grating region where said grating is located and a non-grating region where said grating is not located; and wherein said substrate has a plurality of grating regions.

128. (Previously presented) The method of claim 116 wherein said substrate has a grating region where said grating is located and a non-grating region where said grating is not located; and wherein said grating region has a refractive index that is greater than that of said non-grating region.

129. (Previously presented) The method of claim 116 wherein said substrate has a grating region where said grating is located and a non-grating region where said grating is not located; and wherein said grating region has a refractive index that is not greater than that of said non-grating region.

130. (Previously presented) The method of claim 116 wherein said incident light is incident on said substrate along a longitudinal grating axis of said grating.

131. (Previously presented) The method of claim 116 wherein said incident light is incident on said substrate at an angle to a longitudinal grating axis of said grating.

132. (Currently amended) The method of claim 116 wherein said grating comprises a thin grating or a blazed grating.

133. (Previously presented) The method of claim 116 wherein said substrate comprises a plurality of said gratings.

134. (Previously presented) The method of claim 116 wherein said substrate comprises a particle or bead.

135. (Currently amended) The method of claim 116 wherein said chemical comprises at least one gene, oligonucleotide, protein, antibody, peptide, amino acid, DNA, ~~NDA,~~ cDNA, RNA, nucleic acid oligomer, polymer, or biological cell, or portion thereof.

136. (Currently amended) A method of performing a multiplexed particle assay, comprising:

obtaining a plurality of particles each being made of a substantially single material and having at least one diffraction grating embedded ~~disposed~~ therein, said grating having a resultant refractive index variation within the substantially single material at a grating location~~, said grating being embedded within a substantially single material of said particle~~;

attaching at least one probe to at least one of said particles, thereby providing functionalized particles;

placing said functionalized particles in contact with at least one analyte, said analyte having a corresponding label disposed thereon;

illuminating said particles with ~~at least one~~ a first and second incident light, said particle providing a first output optical ~~light~~ signal responsive to said first incident light indicative of a code and a second output optical ~~light~~ signal responsive to said second incident light indicative of said label, ~~said code identifying at least one of the particles and said probe,~~ said first output optical signal ~~not~~ being a result of passive, non-resonant scattering from ~~laser action with~~ said grating when illuminated by said incident light;

reading said first output optical ~~light~~ signal and detecting said code therefrom; and

reading said second output optical ~~light~~ signal and detecting said label therefrom.

137. (Previously presented) The method of claim 136 wherein said refractive index variation comprises at least one refractive index pitch superimposed at said grating location.

138. (Previously presented) The method of claim 136 wherein said refractive index variation comprises a plurality of refractive index pitches superimposed at said grating location.

139. (Previously presented) The method of claim 136 wherein said particle is made of a material selected from the group: glass, silica, plastic, rubber, and polymer.

140. (Previously presented) The method of claim 136 wherein said code comprises a plurality of digital bits.

141. (Previously presented) The method of claim 136 wherein said code comprises at least a predetermined number of bits, said number being: 3, 5, 7, 9, 10, 12, 14, 16, 18, 20, 24, 28, 30, 40, 50, or 100.

142. (Currently amended) The method of claim 136 wherein said code comprises a plurality of digital bits, each bit having a corresponding spatial location in said first output optical signal and each bit in said code having a binary value related to the intensity of said first output optical signal at the spatial location of each bit.

143. (Previously presented) The method of claim 142 wherein the value of each bit corresponds to the presence or absence of a corresponding refractive index pitch in said grating.

144. (Previously presented) The method of claim 136 wherein said incident light comprises a single wavelength.

145. (Previously presented) The method of claim 136 wherein said substrate has a coating disposed on at least a portion of said substrate, at least a portion of said coating being made of a material that allows sufficient amount of said incident light signal to pass through said material to allow detection of said code.

146. (Previously presented) The method of claim 136 wherein at least a portion of said substrate has a 3-D shape selected from the group: a cylinder, a sphere, a cube, and a pyramid.

147. (Previously presented) The method of claim 136 wherein said substrate has a grating region where said grating is located and a non-grating region where said grating is not located; and wherein said substrate has a plurality of grating regions.

148. (Previously presented) The method of claim 136 wherein said substrate has a grating region where said grating is located and a non-grating region where said grating is not located; and wherein said grating region has a refractive index that is greater than that of said non-grating region.

149. (Previously presented) The method of claim 136 wherein said substrate has a grating region where said grating is located and a non-grating region where said grating is not located; and wherein said grating region has a refractive index that is not greater than that of said non-grating region.

150. (Previously presented) The method of claim 136 wherein said incident light is incident on said substrate along a longitudinal grating axis of said grating.

151. (Previously presented) The method of claim 136 wherein said incident light is incident on said substrate at an angle to a longitudinal grating axis of said grating.

152. (Currently amended) The method of claim 136 wherein said grating comprises a thin grating or a blazed grating.

153. (Previously presented) The method of claim 136 wherein said substrate comprises a plurality of said gratings.

154. (Canceled) The method of claim 136 wherein said substrate comprises a particle or bead.

155. (Currently amended) The method of claim 136 wherein said chemical comprises at least one gene, oligonucleotide, protein, antibody, peptide, amino acid, DNA, ~~NDA,~~ cDNA, RNA, nucleic acid oligomer, polymer, or biological cell, or portion thereof.

156. (New) The method of claim 13, wherein said first and second incident light signals are the same signal.

157. (New) The method of claim 136, wherein said second output optical signal is a result of fluorescences emissions.